Barry Barton

The Denominator Problem
Energy Demand in a Sustainable Energy Policy

Often when people think of policy for long-term sustainability they think of energy supply and not energy demand. What comes to mind often are new sources of supply on the very edge of technology, such as shale gas and deep-sea oil resources; or it may be renewable energy sources, such as hydro, wind, solar, geothermal and biofuels. But if people focus exclusively or excessively on supply, they are overlooking the demand side. How much energy must we produce in order to meet our human and economic needs? What assumptions are we making about future energy demand? In regard to a particular energy project going through an environmental impact assessment process, how do we evaluate whether the project is necessary?

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I have two simple, related points to make about these complex matters, without for a moment professing to have a full answer to them. The first is that the energy demand side is where we should put more of our effort for energy sustainability because, compared to supply, the demand side, including energy efficiency, offers better, quicker and cheaper policy options for reducing greenhouse gas emissions, for reducing the environmental impact of new supplies of energy, and for improving human well-being generally. The demand side calls for more law and policy attention because it involves human behaviour, not only engineering. The second point is that we need to put more effort into connecting our policies for demand and for supply. I will explain these matters briefly in their international context, then more specifically in New Zealand and in relation to electricity policy in particular.

The role of energy efficiency

The demand side points us straight to energy efficiency. The importance and potency of energy efficiency is shown by two different analyses of the way forward on a global scale in order to address climate change. The first is the latest annual *World Energy Outlook* from the International Energy Agency (IEA, 2012).[1] The *World Energy Outlook 2012* offers projections of energy trends to 2035 and insights into what they may mean. To do so it presents several different scenarios, differentiated mainly by their assumptions about government policies globally. The 'new policies' scenario takes into account, in a cautious way, broad policy commitments and plans that have already been implemented or have been announced. The current policies scenario embodies the effects of only those policies that had been adopted at mid-2012. The 450 scenario, in contrast, selects a pathway for actions that have a 50% chance of meeting the goal of limiting the global increase in average temperature to 2°C. Energy efficiency accounts for about 70% of the reduction in projected global energy demand from the current policies scenario to the new policies scenario by 2035, and 74% moving from there to the 450 scenario by 2035. In the abatement of energy-related carbon dioxide emissions, from the new policies scenario to the 450 scenario energy efficiency is projected to provide much the greatest component: 42% of the total abatement by 2035. By contrast, the contribution of renewables to the abatement by that date is 23%, of biofuels 4%, nuclear 8% and carbon capture and storage 17%. It is striking how large a contribution the IEA thinks that energy efficiency measures will make globally.

The second analysis is what has become known as the McKinsey Curve (Enkvist, Dinkel and Lin, 2010): an estimation of the cost and effect of different methods of reducing greenhouse gas emissions. It ranks different technologies in accordance with the cost of abatement per ton of carbon dioxide equivalent, and it assesses the amount of abatement in tons that each one could make beyond 'business as usual' by 2030. The most expensive options include carbon capture and storage, with concentrated solar, photovoltaic solar, wind and nuclear, each costing progressively less. But below them is a group of abatement measures and technologies that cost even less: fuel efficiency in vehicles, water heating, air conditioning, appliances, lighting and building insulation. In fact, these measures have 'negative cost' – they pay for themselves. While the McKinsey Curve is much debated, and (like the *World Energy Outlook*) is at a high level of generality, the key message is clear: energy efficiency is more important and more financially attractive than other technologies and policy measures.

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What exactly is energy efficiency, if it is so important? Energy efficiency is a ratio of function, service or value provided, to the energy converted in order to provide it. In other words, it is the amount of work done in relation to the energy used (IEA, 2009). To increase energy efficiency is to increase the amount of the services that we get out of each unit of energy that we use. It is interesting that in many spheres of human activity the trend is for energy efficiency to improve naturally. The major OECD countries used a third less energy per unit of gross domestic product in 2000 than they did in 1973 (Geller et al., 2006). Cars in America now travel twice as far on a gallon or litre of gas (petrol) as they did in 1970. Lighting is now literally 1,000 times more efficient (in kWh per lumen-hour) than it was in 1300; in price, it is more than 10,000 times cheaper (Fouquet and Pearson, 2006). The challenge from a legal or policy point of view is how to accelerate this trend dramatically.

One would think that people would invest heavily in energy efficiency, for their own good. They do so invest, but they do so to a lesser extent than economic analysis would lead us to expect. People fail to make energy efficiency investments that appear to be rationally justified. To put it another way, people demand a return on investment much higher than they would expect elsewhere, for example in returns on money deposited with a bank. This is not an isolated phenomenon, but is very persistent. It is seen in households and in major companies, and is seen among both the rich and the poor. The phenomenon has come to be known as the 'energy efficiency gap' – a series of barriers that inhibit investment (Interlaboratory Working Group, 2000; IEA, 2008). Several barriers can be identified. The 'principal-agent' gap is exemplified by the division of costs and benefits where a landlord is not interested in investing in extra house insulation or in better heating appliances because the benefits will be reaped by the tenant, without a direct influence on the rent the landlord can charge. Other barriers which have been identified are information gaps, aversion to risk, and the presence of multiple gatekeepers whose approval or disapproval will influence an investment in energy-efficient technology.

Social and psychological investigations of energy use have been undertaken for quite some time, but they have not often been well integrated with conventional economics or with the making of law and policy. Human behaviour with respect to energy efficiency is complex and challenging. No single approach is entirely successful. One multidisciplinary effort sought to make sense of energy behaviour in New Zealand households, with a particular focus on household space heating and water heating. It used several different social science methods, chiefly choice modelling and a national household survey with cluster analysis. It developed an integrated model of energy cultures: cognitive norms, material culture and energy practices; that is, what we think, what we have and what we do (Stephenson et al., 2010). Using this framework, it was possible to identify different groups of energy users, which are probably amenable to different energy efficiency policy tools (Lawson and Williams, 2012).

Energy efficiency measures worldwide

Over the years, governments worldwide have devised a number of different policy measures to improve the uptake of energy efficiency (Eusterfeldhaus and Barton, 2011; Pasquier and Saussay, 2012; Ryan and Campbell, 2012). Information and education campaigns are among the simplest. Another that is apparently simple is a minimum energy performance standard or MEPS, which requires all appliances of a certain description – refrigerators, air conditioning units – to meet minimum standards of efficiency. Minimum energy performance standards work to eliminate the least efficient products from the marketplace. An MEPS that has been controversial in several countries is one to eliminate the traditional incandescent light bulb from regular use, and to replace it with compact fluorescent bulbs or other efficient light sources. A less intrusive requirement is for energy performance of a product or a vehicle to be stated on a label so that a prospective purchaser can make an informed decision. Subsidies can be used to encourage and enable people to invest in insulation or in replacing obsolete appliances. In some countries, although not New Zealand, energy companies selling electricity or natural gas can be required to produce demand-side management programmes where they make it easy for their customers to reduce or modify their energy needs. Other efficiency measures are found in building codes and in motor vehicle fleet performance standards. Nevertheless, simple price signals are often not enough to encourage energy efficiency; usually, a multitude of non-price barriers exist and prevent the uptake of efficient systems no matter how high the price of energy goes.

There is debate internationally about the efficacy of energy efficiency measures (Herring, 2006). This includes arguments about a rebound effect, where some of the efficiency gains are taken up by increased use of the service in question: if we use less fuel per kilometre, we are more tempted to go on longer trips. Energy efficiency measures can also be criticised for their effect on low-income households. However, detailed analyses provide a full rebuttal of these criticisms (Geller and Attali, 2005; Geller et al., 2006, p.556; IEA, 2009). Energy efficiency policy measures do work. They need to be carefully designed, and they need to distinguish between the promises of the engineering potential of a system and the operation of the system in practice.

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California is a remarkable example of a jurisdiction where energy efficiency policies have been steadily and systematically applied for several decades with great success. The state uses less electricity per person than any other state in the United States. While per capita electricity consumption in the United States increased by nearly 50% over the past 30 years, California's per capita electricity use remained almost flat, due in large part to cost-effective building and appliance efficiency standards and other energy efficiency programmes (California Energy Commission and California Public Utilities Commission, 2008, p.6; Sachs, 2009, p.316). The legal framework is found in requirements for energy supply companies to provide 'energy efficiency portfolios' and budgets as a condition of regulatory approval. Another requirement affects decisions to build new power stations; the California Public Utilities Code §454.5 states as follows:

(b) An electrical corporation's proposed procurement plan shall include, but not be limited to, all of the following ...

(9) A showing that the procurement plan will achieve the following: ...

C) The electrical corporation will first meet its unmet resource needs through all available energy efficiency and demand reduction resources that are cost effective, reliable, and feasible.

Since 2003 California's energy law and policy has defined a 'loading order' of resource additions to meet the state's needs for electricity: first, energy efficiency and demand response; second, renewable energy and distributed generation; and, third, clean fossil-fueled sources and infrastructure improvements. This strategy has had the benefit of reducing CO2 emissions and diversifying sources of energy (California Energy Commission and California Public Utilities Commission, 2005; California Energy Commission, 2009). Energy efficiency is absolutely central in the state's energy law and energy policy. It is not peripheral in any way.

Energy efficiency policy-making in New Zealand

Present energy efficiency policy in New Zealand is developed under the legal framework of the Energy Efficiency and Conservation Act 2000. Section 5 of the Act states its purpose: 'to promote, in New Zealand, energy efficiency, energy conservation, and the use of renewable sources of energy'. It establishes the Energy Efficiency and Conservation Authority; it provides for the making of national energy efficiency and conservation strategies (NEECS); and it provides for the making of regulations for labelling and for minimum energy performance standards. By international standards, therefore, New Zealand has a far-reaching and progressive legal basis for the promotion of energy efficiency. Some aspects have been very successful. In particular, a subsidy programme for household insulation and heating, called 'Warm Up New Zealand: Heat Smart' and administered by the EECA, has been very successful and very good value for money (Grimes et al., 2012).

However, strategic direction in New Zealand under national energy efficiency and conservation strategies has been less successful. Although the first and second NEECSs had a number of positive elements, that of 2011 (Ministry of Economic Development, 2011) has a number of defects. It proposes that New Zealand continue to achieve a rate of improvement of energy intensity of 1.3% per annum. This target is an energy intensity rather than energy efficiency target. But the most extraordinary thing about it is that it is merely the reference scenario figure that is expected to occur anyway between 2010 and 2030, arising not out of policy action but out of the ordinary uptake of new efficient technology and possibly higher energy prices (Ministry of Economic Development, 2010). This is not taking energy efficiency policy seriously; it must be unprecedented for a policy target to be the same figure as is expected without policy action.

The poor treatment of energy efficiency is seen elsewhere in the NEECS of 2011. The strategy proposes seven sector-specific strategies and targets to achieve the overall rate of 1.3% per annum. Two of the targets are for renewable energy. One is for woody biomass and direct geothermal use in business. The other (which we will consider in more detail shortly) is that by 2025 '90% of electricity will be generated from renewable sources, providing security of supply is maintained' (Ministry of Economic Development, 2011, p.18). These two renewables targets have merit in being ambitious above present levels of performance, and in being specific and numeric. The third target is for household energy efficiency: that 188,500 homes be insulated by 2013. Again that is specific and numeric, which is good, but it is work that is well under way under the existing Warm Up New Zealand: Heat Smart programme.[2] The fourth is for products: to extend minimum energy performance standards, labelling and Energy Star product coverage 'to remain in line with major trading partners'. This is not specific and numeric, and even less ambitious. The last three targets are all for energy efficiency in transport, business and the public sector, and they are all phrased as targets of improvement from 2010 levels; but because no amount of improvement is stated, anything at all would qualify. This is unusual and unsatisfactory policy-making. We therefore see a pattern where the two renewables targets are couched in credible terms, and may well make a difference, but the five efficiency targets are weak. Energy efficiency is the poor cousin even in the national energy efficiency and conservation strategy itself.

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There are other problems with the strategy. It is vague about the policy actions that will be undertaken to achieve the various targets; often no actions are stated at all. The targets are unconnected to the 1.3% per annum target in how much each will contribute. They are not supported by continuous data on energy efficiency, or by any evaluation of the success of existing policies; indeed, there is no reference to previous NEECSs (Eusterfeldhaus and Barton, 2011). Many of the criticisms made by the IEA of the draft relate also to the final document (IEA, 2010, p.50). Given the potential of energy efficiency to contribute to a more sustainable energy future, it is plain that the key strategy requires a great deal more policy effort than it has had.

Energy efficiency and renewables policy: the denominator problem

At this point we can turn to consider the connection between energy efficiency on the demand side and energy supply. There are many aspects to that relationship in an overall energy policy framework, and many of them are hugely challenging. One need think only of the complexities of transport, where much of New Zealand's fossil fuel consumption occurs, or building use and technology. But one matter is a vivid example of the relationship between supply and demand in a sustainable energy policy framework, and of the weakness of our present arrangements: renewable electricity generation.

The NEECS of 2011 (Ministry of Economic Development, 2011, p.18) continues the 2007 NEECS policy target of 90% renewable generation of electricity by 2025 (New Zealand Government, 2007), adding a proviso that security of supply is maintained. The target is referred to by a national policy statement under the Resource Management Act 1991 (RMA) (New Zealand Government, 2011). At present, renewable sources (mainly hydro, with some geothermal and a little wind) account for most of New Zealand's total electricity generation. In 2011, total generation was 43,138 GWh (gigawatt hours), of which renewables was 33,097 GWh or 76.7% (Ministry of Economic Development, 2012, p.108). (The amount varies according to rainfall.) Ninety per cent renewables would be 38,824 GWh; on present consumption, there is a gap of 5,727 GWh to reach the target. The ministry reference scenario (Ministry of Economic Development, 2011a, p.6) for 2025 is for electricity demand of 52,000 GWh: 90% of that is 46,800 GWh, which leaves a gap of 13,703 GWh of new renewable electricity generation to find.

But would these requirements change if demand for electricity was moderated by vigorous energy efficiency policies? What if demand for electricity could be kept at present levels? (This may sound extravagant, especially if one thinks of likely population growth by 2025, but it simplifies the policy point; it is not forecasting.)[3] Less than half the amount of new renewable generation capacity would have to be built. To put it in concrete terms, let us use the Clyde Dam power station as a unit of measure. (The Clyde Dam was the last of the country's large hydro projects, and was intensely controversial.) Clyde, rated at 432 MW, produces about 2,100 GWh of electricity per annum. To achieve the 90% target on present consumption would require 2.7 Clyde Dams. To achieve the target on the 'business as usual' reference scenario for 2025 would be 6.5 Clyde Dams. So if we can stabilise demand, even if only to some degree, we do not need to invest nearly so much in renewable or any other kind of electricity generation. The main lesson from this 'denominator problem' is that we should focus not only on the '90' part of the fraction, the numerator, but also on the '100', the denominator – 90% of how much electricity?

The denominator problem received consideration by the Board of Inquiry into the Proposed National Policy Statement on Renewable Electricity Generation (Board of Inquiry into the Proposed National Policy Statement on Renewable Electricity Generation, 2010, paras 38-39 and 60, recommendation policy B.1).[4] The board saw a need for demand-side management to be taken into account in RMA policy-making in order to reduce the demand for new renewables. However, Cabinet decided to remove the reference to demand-side management, lest power companies be required to invest in energy efficiency before getting resource consents for renewable developments (Minister for the Environment, 2011).

Renewable energy sources have effects on the environment, even though their emissions of greenhouse gases and pollutants are low. New Zealand, like other countries, has seen much controversy about hydro generation projects, such as the Mokihinui River proposal, or wind farms, such as Project Hayes. Indeed, advocates for wild rivers will claim that hydroelectric generation is truly renewable only if the power company can create a new river. The supply of renewable energy has a negative side, just as do other sources of supply. The Parliamentary Commissioner for the Environment has considered the matter recently, not as to energy demand but as to protection of wild rivers by water conservation orders under the Resource Management Act (Parliamentary Commissioner for the Environment, 2012). Decision-makers are directed under the RMA section 7 to have particular regard to both the efficiency of the end use of energy and the benefits to be derived from the use and development of renewable energy. On the whole these considerations have strongly supported renewable energy projects in the resource consenting process (Palmer, 2011, p.145; Fisher, 2005). But the main reason why energy demand is not evaluated in RMA proceedings is that the need for a project is generally not a prerequisite for the grant of a resource consent for it. That is an issue of commercial judgement.[5] The RMA is oriented towards an examination of the adverse effects of projects, and away from economic planning. It would be difficult to re-direct the Act for the sake of energy demand alone, although that still leaves many opportunities under it to pursue demand management and energy efficiency more vigorously. Interestingly, for transmission lines, which may well accompany a renewable generation project, the need for the project will be scrutinised by the Commerce Commission in the approval of a grid upgrade plan.[6]

Conclusion

To move towards an energy policy framework which produces long-term sustainability we need the demand side and energy efficiency to have a more central place than they do now. Policy action in relation to energy efficiency is not easy because it involves the complexities of human behaviour, but its substantial benefits are well recognised. We have considerable weaknesses in energy efficiency law and policy in New Zealand. The denominator problem that this article has particularly noted, of the relationship between a renewables target and the question of energy demand and energy efficiency, shows the need for a clear workable link or connection between different energy policy components. A good framework will guide project-specific decisions. Exactly how to make that connection is not easy – all the more reason for the matter to receive considerable policy effort.

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1 The *World Economic Outlook 2012* also introduces the efficient world scenario, which quantifies the effects of a major step-change in energy efficiency, assuming that all investments capable of improving energy efficiency are made, so long as they are economically viable, and any market barriers to them are removed. It sees substantial reductions

for demand for oil and coal by 2035. Getting there requires a public policy on energy efficiency that will: make it visible; make it a priority; make it affordable; make it normal; make it real; and make it realisable (pp.302, 322).

2 In 2011–12, 63,000 houses were insulated, taking total retrofits under the programme to 164,000 (Energy Efficiency and Conservation Authority, 2012).

3 But in fact growth in electricity demand has slowed noticeably, to 0.5% p.a. 2007–11 (Ministry of Economic Development, 2012, p.108).

4 The board did not use the term 'denominator problem' in its report, but I gladly acknowledge the origins of the term, and the insight that it contains, in the work of the board, and I thank the chairperson of the board, Royden Somerville QC, for valuable discussions of the matter.

5 Fletcher v Auckland City Council, Environment Court A82/07, 28 September 2007, at p.43; see Palmer (2011) p.121. Similarly, but mainly in relation to alternative locations, it has been held that an applicant is not required to demonstrate that its proposal represents the best use of the subject resources or is best in net benefit terms: Meridian Energy Ltd v Central Otago District Council [2011] 1 NZLR 482.

6 Electricity Industry Act 2010 s155, Commerce Act 1986 ss54R-54S. See Barton (2012).

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